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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/585,994	07/13/2006	Yasuo Kobayashi	33082M336	8859
441 7590 10/08/2009 SMITH, GAMBRELL & RUSSELL 1130 CONNECTICUT AVENUE, N.W., SUITE 1130 WASHINGTON, DC 20036			EXAMINER PARENDO, KEVIN A	
			ART UNIT 2823	PAPER NUMBER
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**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

# Office Action Summary

**Application No.**

10/585,994

**Applicant(s)**

KOBAYASHI ET AL.

**Examiner**

Kevin Parendo

**Art Unit**

2823

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 20 July 2009.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-5 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-5 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO/SF/ICE)  
Paper No(s)/Mail Date \_\_\_\_\_
- 4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date \_\_\_\_\_
- 5) ☐ Notice of Informal Patent Application
- 6) ☐ Other: \_\_\_\_\_

## DETAILED ACTION

### *Claim Rejections - 35 USC § 112*

The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

1. Claims 1-5 are rejected under 35 U.S.C. 112, first paragraph, because the specification, while being enabling for using SiCO and SiCN to adhere well to silicon carbide films that are barrier layers that are on copper layers and that prevent diffusion of the copper (see paragraphs 5, and 32 and 34-35, of specification as filed), does not reasonably provide enablement for merely forming a SiCO on a SiCN on a CF layer, in a claim that lacks any connection to copper interconnects and SiC barrier layers. The specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to use the invention commensurate in scope with these claims.

As currently claimed, **claim 1** merely requires forming the SiCO on SiCN on CF. The claim does not require the copper layer or the silicon carbide layer, which are the motivations for forming the SiCO and SiCN in the specification, as described in paragraphs 5, 32, and 34-35, as shown in Fig. 4D/6K. As claimed, the limitations allow these layers to be formed in any device, even devices that lack copper interconnects. Of course one of ordinary skill in the art could randomly form these layers as claimed on, say, the metal plate of a capacitor in a portion of a semiconductor device that lacks

any copper interconnects, but would not be using the invention for any of the benefits or in any comparable way to those described in the specification, and the specification has not taught one of ordinary skill in the art how to use these layers in any meaningful way in other types of devices. It is deemed that some linking to a copper interconnect and to a silicon carbide barrier layer is needed in claim 1 to overcome this deficiency. **Claims 2-5** depend from claim 1 and inherit its deficiencies.

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claims 1-5 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

**Claim 1** recites the limitation "depositing on the protective layer a thin film serving as a hardmask" on line 5. The metes and bounds of the claimed limitation can not be determined for the following reasons: it is unknown what "serving as a hardmask" requires exactly. The claim first requires "a thin film", which could be interpreted as **94** in Fig. 4. The claim does not require "a thin film having a hole therethrough" or similar limitations to require a patterned hardmask. However, does a "thin film" such as **94** in Fig. 4 "serve as a hardmask", or does it need to be patterned with a hole (such as in Fig. 5H) to do so? It may be reasonable to interpret that it does, because it would mask the underlying layer during any etching process. Does the hole actually have to be etched through the thin film layer and into lower layers, to pass the shape of the

patterned hardmask into a lower layer, to be "serving as a hardmask"? Thus, the scope of the claim is unclear. **Claims 2-5** depend from claim 1 and inherit its deficiencies.

In light of the aforementioned rejections of the claim(s) under 35 U.S.C. 112, the subsequent rejections under 35 U.S.C. 102 and/or 103 are based on prior art that reads on the interpretation of the claim language of the instant application as best understood by the examiner.

### ***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

The examination guidelines for determining obviousness under 35 U.S.C. 103 are described in MPEP 2141-2145.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

3. Claims 1-4 are rejected under 35 U.S.C. 103(a) as being unpatentable over US 6,429,518 ("Endo") in view of US 2003/0003765 A1 ("Gibson").

**Re claim 1**, Endo discloses a manufacturing method of a semiconductor device, comprising the steps of:

- depositing on a substrate (**Cu** or wafer, **W**, column 4, line 32 and Fig. 12) a dielectric film **710** made of fluorine-added carbon (CF, column 15, line 2 and Fig. 12); and
- forming on the dielectric film a protective layer **830** (SiCN, column 14, line 67 and Fig. 12) comprising a nitrogen-added silicon carbide film;

Endo does not disclose depositing on the protective layer a thin film serving as a hardmask made of oxygen-added silicon carbide by a plasma containing active species of silicon, carbon, and oxygen.

Gibson discloses depositing on the protective layer **11** (SiCN, paragraph 26 and Fig. 2) a thin film **13** (SiOC, paragraph 26 and Fig. 2) serving as a hardmask made of oxygen-added silicon carbide ("oxygen-doped silicon carbide," paragraph 26) by a plasma (plasma chemistry in PECVD, paragraph 26) containing active species of silicon, carbon, and oxygen (paragraph 26).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to add the oxygen-doped silicon carbide of Gibson to the invention of Endo. The motivation to do so is that the combination produces the predictable results of forming an upper barrier layer of oxygen-doped silicon carbide on a lower barrier layer of nitrogen-doped silicon carbide, the layer **13** effective at isolating layer **11**

from a subsequently formed low-k dielectric material **17** (paragraphs 7 and 26 and Fig. 2).

**Re claim 2**, Endo and Gibson disclose the limitations of claim 1, as discussed above, but Endo does not disclose the oxygen-doped silicon carbide, and thus does not disclose that the plasma containing active species of silicon, carbon, and oxygen is a plasma obtained by activating a gas of an organic silicon compound and an oxygen gas.

Gibson discloses that the plasma containing active species of silicon, carbon, and oxygen is a plasma obtained by activating a gas of an organic silicon compound (tetra-methyl-silane, paragraph 26) and an oxygen gas (carbon dioxide, paragraph 26). It would have been obvious to one of ordinary skill in the art at the time the invention was made to add the oxygen-doped silicon carbide and its methods of formation of Gibson to the invention of Endo. The motivation to do so is that the combination produces the predictable results of forming an upper barrier layer of oxygen-doped silicon carbide on a lower barrier layer of nitrogen-doped silicon carbide, the layer **13** effective at isolating layer **11** from a subsequently formed low-k dielectric material **17** (paragraphs 7 and 26 and Fig. 2).

**Re claim 3**, Endo further discloses that the step of forming the protective layer includes the sub-steps of:

- depositing on the dielectric film a silicon carbide film **810/820** (SiC, column 14, line 67 and Fig. 12) by a plasma containing active species of silicon (SiH<sub>4</sub>, column 15, line 33) and carbon (C<sub>2</sub>H<sub>4</sub>, column 15, line 33); and

- depositing on the silicon carbide film a nitrogen-added silicon carbide film **830** (SiCN, column 14, line 67 and Fig. 12) by a plasma containing active species of silicon, carbon, and nitrogen (SiH<sub>4</sub>, C<sub>2</sub>H<sub>4</sub>, and N<sub>2</sub>, column 15, line 43).

**Re claim 4**, Endo further discloses that the step of forming the protective layer includes the sub-steps of:

- depositing on the dielectric film a silicon carbide film **810/820** (SiC, column 14, line 67 and Fig. 12) by a plasma obtained by activating a gas of a silicon compound (SiH<sub>4</sub>, column 15, line 33); and
- depositing on the silicon carbide film a nitrogen-added silicon carbide film **830** (SiCN, column 14, line 67 and Fig. 12) by a plasma containing active species of an organic silicon compound (SiH<sub>4</sub>, column 15, line 43) and active species of nitrogen (N<sub>2</sub>, column 15, line 43).

Endo does not further disclose that the silicon compound is an organic silicon compound.

Gibson discloses silicon compounds that are organic (tetra-methyl-silane, paragraph 26).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to add the organic silicon of Gibson to the invention of Endo. The motivation to do so is that the combination produces the predictable results of forming the silicon carbide and nitrogen-added silicon carbide films with a material that is effective at forming a barrier film (paragraph 7).



The applicant has not disclosed that the claimed material (organic silicon) is for a particular unobvious purpose, produces an unexpected result, or is otherwise critical, which are criteria that have been held to be necessary for material limitations to be prima facie unobvious. The claimed material is considered to be a "preferred" or "optimum" material out of a plurality of well known materials that a person of ordinary skill in the art at the time the invention was made would have found obvious to provide to the invention of the cited prior art reference, using routine experimentation and optimization of the invention. In re Leshin, 125 USPQ 416 (CCPA 1960).

4. Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Endo and Gibson, as applied to claim 1, above, further in view of US 7,199,046 B2 ("Wetzel").

**Re claim 5**, Endo and Gibson disclose the limitations of claim 1, as discussed above, but do not further disclose:

- forming on the thin film serving as a hardmask a resist film having a specific pattern;
- etching the thin film by a plasma through the resist film to obtain a hardmask having a pattern corresponding to that of the resist film; and
- etching the dielectric film by a plasma through the hardmask.

Wetzel discloses

- forming on the thin film **135** serving as a hardmask, a resist film **145** (column 6, line 15-16 and Fig. 1A) having a first pattern;

- etching the thin film by a second plasma through the resist film to obtain the hardmask having a second pattern (column 6, line 40 and Fig. 1B) corresponding to the first pattern; and
- etching the dielectric film by a third plasma through the hardmask (column 7, line 53-54 and Fig. 1G).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to add the resist film pattern and etching steps of Wetzel to the invention of Endo and Gibson. The motivation to do so is that the combination produces the predictable results of forming a trench/via structure **150/155** (column 8, lines 4-7) used in a "dual-damascene structure" (column 3, lines 62-65) to allow for metal interconnects to be formed in the film stack (column 2, lines 49-50).

### ***Double Patenting***

The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory obviousness-type double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement.

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

5. Claim 1 is provisionally rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 3-4 of copending Application No. 12/157795 (hereinafter called '795), in view of Endo.

Although the conflicting claims are not identical, they are not patentably distinct from each other because claims 1-8 are largely identical to the subject matter of claims 3-4.

Claim 1 requires forming an oxygen-added silicon carbide film on a nitrogen-added silicon carbide film on a fluorine-added carbon film on a substrate. Claim 3 of '795 requires forming a film containing silicon and oxygen (which is explicitly claimed as an oxygen added silicon carbide film in claim 4) on a film containing silicon, carbon, and nitride, on a film of silicon nitride, on a fluorine-added carbon film, on a substrate. It would have been obvious to one of ordinary skill in the art at the time of invention that a "film containing silicon, carbon, and nitride" is an obvious wording of "nitrogen-added silicon carbide", and that these phrases contain the same limitation. The claims each require "active species" of the constituent gases.

Since claim 1 contains the limitations of copending claims 3-4 of '795, minus the first SiN barrier, then claim 1 is obvious over claims 3-4 of '795, because it would have been obvious to form a SiCN/SiN barrier between the CF and the SiOC, because Endo teaches a SiCN/SiN barrier **830/820** (Fig. 11) on a CF film, and it would have been obvious to one of ordinary skill in the art at the time of invention to add the SiCN/SiN

barrier to the invention of the present claim 1 because these layers increased adhesion between the CF and a subsequently formed copper line (column 16, lines 12-14).

This is a provisional obviousness-type double patenting rejection because the conflicting claims have not in fact been patented.

### ***Response to Arguments***

6. Applicant's arguments with respect to claims 1-5 have been considered but are not persuasive.

7. Regarding the Endo/Gibson combination, the applicant argues (see page 7 of remarks) that "according to the present invention, the dielectric film made of fluorine-added carbon (CF)... has to be adjacent to the protective layer including the nitrogen-added silicon carbide film (SiCN) in order to (1) decrease the amount of degassing from the fluorine-added carbon film, and (2) avoid sublimation of SiF<sub>4</sub> during the annealing process." This argument is unpersuasive for multiple reasons.

First, the claim does not require the CF to be adjacent to the SiCN film. While it may be shown as such in the figures, the claim does not require this, and only requires the SiCN film to be "on" the CF film. Much like a bowl may be on a table even though there is a tablecloth in between the bowl and the table, the claim does not require the SiCN to be "directly on" or "directly adjacent" the CF. Thus, Endo does indeed form a SiCN film "on" the CF film. Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

Also, the decrease of outgassing and the avoiding of sublimation are not claimed limitations. Thus, they do not need to be disclosed by either reference. The examiner has indicated in the rejection that it would be obvious to form the SiOC on the SiCN, as taught by Gibson, and the SiCN is already on the CF, as taught by Endo. Thus, it would be obvious to form the low-k dielectric on the SiOC on the SiCN on the CF. The motivation for doing so is given above -- forming an upper barrier layer of oxygen-doped silicon carbide on a lower barrier layer of nitrogen-doped silicon carbide, the layer 13 effective at isolating layer 11 from a subsequently formed low-k dielectric material 17 (paragraphs 7 and 26 and Fig. 2). While this motivation is different than (1) and (2), the motivation for combining references does not need to correspond to the applicant's motivation for the invention, because the fact that applicant has recognized another advantage which would flow naturally from following the suggestion of the prior art cannot be the basis for patentability when the differences would otherwise be obvious. See *Ex parte Obiaya*, 227 USPQ 58, 60 (Bd. Pat. App. & Inter. 1985).

8. Later, it is argued that the CF film "can not be adjacent to the hardmask made of oxygen-added silicon carbide (SiCO). The examiner has indicated in the rejection that it would be obvious to form the low-k dielectric on the SiOC on the SiCN, as taught by Gibson, and the SiCN is already on the CF, as taught by Endo. Thus, it would be obvious to form the low-k dielectric on the SiOC on the SiCN on the CF. There is no suggestion or taught necessity in Gibson or Endo that the CF must be adjacent to the SiCO.

**Conclusion**

9. This action is made non-final, because the rejections under Endo/Wetzel in the previous rejections had inadvertent errors (the motivation was lost, and the rejection mistakenly referred to Gibson). The examiner has also added 112 rejections to require clarification of the scope of the claims.

10. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure: there are many inventions involving copper interconnects that have SiC, SiN, or SiO based layers used for barrier, protection, and adhesion purposes. For example, US 2004/0036076 A1 ("Arita") has layers 7, 6, and 4, all of which may be such types of layers, formed on a CF layer 3. US 6,767,746 B2 ("Matsuura") has layers 12, 10, 8, and 5, all of which are these types of layers, formed on CF layer 4. Various benefits to specific materials are known (in Matsuura, layer 8 is SiOC and is used as a barrier against copper diffusion, SiON and SiC are used as hardmask materials, SiC is an etch-stop material; in Arita, SiO<sub>2</sub>, SiN, SiC, SiON, SiCN may all be used for capping materials, and SiC, SiN, SiON, SiCN are all useful as etching masks). It seems that many of these materials are interchangeable for given purposes. If the applicants have discovered that specific materials applied directly on and touching each other has unexpected results that can differentiate over the somewhat known interchangeability of materials used in barrier layers and hardmasks, it would be beneficial to attempt to claim such touching or direct contact and benefits thereof.

11. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kevin Parendo, whose can be contacted by phone at (571) 270-5030 or directly by fax at (571) 270-6030. The examiner can normally be reached on Mon.-Thurs. and alternate Fridays from 7 a.m. - 4:30 p.m. EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Smith, can be reached on (571) 272-1907. The fax number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Kevin A. Parendo/  
Examiner, Art Unit 2823  
10/8/2009

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